

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

Surface Drainage – Main or Lateral

(Feet)

Code 608

DEFINITION

An open drainage ditch constructed to a designed size and grade.

PURPOSES

To dispose of excess surface or subsurface water, intercept ground water, control ground water levels; provide for leaching of saline or alkali soils, or a combination of these objectives.

CONDITIONS WHERE PRACTICE APPLIES

All lands to be drained shall be suitable for agriculture after installation of required drainage and other conservation practices.

In areas where an outlet for the drainage system will be available, either by gravity flow or by pumping. The outlet shall provide for the quantity and quality of water to be disposed of. Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions.

CRITERIA

The design and installation shall be based on adequate surveys and investigations.

Drainage requirements. Mains and laterals shall be located and designed to serve as integral parts of a surface or subsurface drainage system that

meets the conservation and land use needs. The degree of drainage required by the crops shall be determined and expressed in terms of drainage coefficients or depth and spacing of drains.

Capacity. The ditch capacity shall be adequate to provide for the removal of excess water, based on climatic and soil conditions and needs of crops. The required capacity shall be obtained by determining the watershed area; the required topographic, soil, and land use information; and use of the appropriate drainage coefficient curves.

Guidelines for capacity, depth and spacing of main or lateral drains are contained in the Indiana Drainage Guide and the Engineering Field Manual.

Hydraulic gradeline. The hydraulic gradeline for drainage ditch design shall be determined from control points, including elevations of significant low areas served by the ditch and hydraulic gradelines of any tributary ditches and the outlet. If control point elevations are estimated rather than computed from survey data, the hydraulic gradeline shall be no less than:

1. One (1) ft below fields that will receive normal drainage from ditches draining more than one (1) square mile.
2. 0.5 ft for ditches draining 40 to 640 acres.
3. 0.3 ft for ditches draining less than 40 acres.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

For lands to be used only for water-tolerant crops, such as trees and grasses, these requirements may be modified and the hydraulic gradeline set at ground level. These provisions do not apply to channels where flow is contained by dikes.

The effects of hydraulic losses caused by culverts, bridges, or other obstruction in the channel section shall be considered.

Depth. Drainage ditches shall be designed deep enough to allow for normal siltation. If needed, the design depth and capacity may be increased to provide adequate subsurface drainage or for normal flow. The increase shall be based on an evaluation of site conditions. Ditches that serve as outlets for subsurface drains shall be designed for a normal water surface at or below the invert of the outlet end of the drain. The clearance between a drain invert and the ditch bottom shall be at least 1 ft for ditches that fill with sediment at a normal rate, except where lower values are specified for a job because of unusual site conditions. The normal water surface is the elevation of the usual low flow during the growing season.

Cross section. The design ditch cross section shall be set below the design hydraulic gradeline and shall meet the combined requirements of capacity, limiting velocity, depth, side slopes, bottom width, and, if needed, allowances for initial sedimentation. Side slopes shall be stable, shall meet maintenance requirements, and shall be designed on the basis of on-site conditions. Side slopes no steeper than 2:1 shall be used unless justified by unusual site conditions.

Velocity. The maximum permissible design velocity shall be based on site conditions and shall insure stability of the ditch bottom and side slopes. A desirable minimum velocity is 1.5 ft/s. Second, on flat grades, a channel cross section shall be selected on the basis of the depth and maintenance requirements, which will result in the desirable minimum velocity if possible.

The velocity for newly constructed channels with drainage areas in excess of one (1) square mile

shall meet the stability requirements specified for open channels (582).

Maximum channel velocities for drainage areas less than one square mile shall conform to the table on page 14-26 of the Engineering Field Manual. This design velocity shall be based on: (a) bankfull flow, (b) the design discharge, or (c) the 10-year frequency, 24-hour duration flow, whichever is smaller.

Capacity design. Manning's Formula shall be used in determining the design velocity, and the value of "n" shall be based on alignment, probable vegetative growth expected with normal maintenance, other roughness factors, and the hydraulic radius. Unless special site studies are available to justify other values, the following values of "n", based on the hydraulic radius of the channel and assuming an aged channel with good maintenance and good alignment, shall be used in solving the Manning Formula for mains and laterals when determining the design for required capacity.

Hydraulic radius	"n"
Less than 2.5	0.040 – 0.045
2.5 to 4.0	0.035 – 0.040
4.1 to 5.0	0.030 – 0.035
More than 5.0	0.025 – 0.030

Berms and spoil banks. Adequate berms shall be provided and shaped, as required, to provide access for maintenance equipment, to eliminate the need for moving spoil banks in future operations, to provide for work areas and facilitate spoil bank spreading, to prevent excavated material from washing or rolling back into ditches, and to lessen sloughing of ditchbanks caused by heavy loads too near the edge of the ditchbanks. The following minimum berm widths shall be provided, except where spoil is spread according to the engineering standard for spoil bank spreading:

Ditch depth (feet)	Minimum berm width (feet)
2.0 – 6.0	8
6.1 – 8.0	10
More than 8	15

If spoil material is to be placed in banks along the ditch rather than spread over adjacent fields, the spoil banks shall have stable side slopes. Provision must be made to channel water through the spoil and into the ditch without causing serious erosion.

Related structures and ditch protection. Mains and laterals shall be protected against erosion by chutes, drop structures, pipe drops, other suitable structures or grassed waterways, or specially graded channel entrances where surface water or shallow ditches enter deeper ditches.

Grade control structures, streambank protection, or other suitable measures shall be used if necessary to reduce velocities and control erosion.

Culverts and bridges shall have enough hydraulic capacity and depth for drainage needs and to minimize obstruction of flow.

Capacities of pipe or drop structures generally shall be determined by use of the applicable drainage coefficients with the "island-type" of construction used to protect the structure from washout.

Each structure for an open ditch system shall be designed according to NRCS standards for the kind of structure and type of construction used.

The minimum capacity of culverts and bridges shall be sufficient to pass the design flow without significant overflow of the channel. All new bridges and culverts must meet the requirements of state and local laws and ordinances. The following capacities are recommended as minimum:

Farm field crossings - Design discharge where overbank flow will not cause erosion when water reenters the channel

Private drives - 2-yr, 24-hr duration frequency

Town, county and rural

roads - 10-yr, 24-hr duration frequency or local government requirements

State highways - As determined by Department of Transportation

Structures used to lower water into mains or laterals shall be designed in accordance with grade stabilization structure, (410).

Vegetated cover. An adequate cover of grasses and legumes shall be established on all disturbed areas in accordance with the vegetative establishment section of the construction specifications.

Fencing. The practice shall be adequately fenced when necessary to prevent damage from livestock. All fencing shall be in accordance with standards and specifications 382, fencing.

CONSIDERATIONS

Main or lateral surface drainage should be part of the treatment needed to protect soil, water, plant, animal and air resources. In addition, a conservation cropping system, conservation tillage, crop residue management or other appropriate system should be planned to control erosion to the area draining to the practice. The management system must be planned to prevent excessive maintenance and operation problems.

Effects of water quantity and quality shall be considered. The practice generally increases runoff and provides more uniform soil water. In other cases, ditches may lower water tables and provide an opportunity for increased infiltration and decreased runoff. Evaporation may be reduced because of the elimination of ponded surface water. Transpiration from crops grown in the field, following practice installation, may exceed that of the previous vegetation because of improved growth environment. Increased ground-water recharge may occur from the ditch where permitted by hydrogeologic conditions.

Drainage waters may transport significant loadings of sediment and dissolved and sediment-attached substances. Phosphorous loadings from surface drainage of cropland may

be increased to the point where eutrophication would be increased in ponded receiving waters. Construction of this practice will temporarily increase erosion and sediment yield but this condition will diminish because of the vegetation of the ditch banks. Where drained water has good quality, the quality of the receiving water may improve. Wildlife habitat may be improved although habitat created by standing water may be reduced.

Component practices constructed as part of a main or lateral surface drain will significantly reduce soil erosion and improve water quality. There may also be a minor increase in the transport of soluble pesticides from the site due to chemicals used for vegetation control in or along the drain. The amount of any pesticide leaving the site in surface flow will depend on the type and amount of pesticide used, soil characteristics, and precipitation patterns at the time of pesticide use. There may be minor changes in ground water quality which result from the infiltration of small amounts of soluble pesticides used to control vegetation in and along the drain.

Special attention shall be given to maintaining and improving visual resources and habitat for fish and wildlife where applicable. The landowner/user will be advised if wetlands will be affected and USDA-NRCS wetland policy will apply. All work planned shall be in compliance with General Manual Title 450-GM, Part 405, Subpart A, Compliance with Federal, State, and Local Laws and Regulations. If archaeological or historical properties are encountered, the USDA-NRCS policy in General Manual Title 420-GM, Part 401 shall be followed.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing mains or laterals shall be in keeping with this standard and shall describe the requirements for constructing the practice to achieve its intended purpose.

Construction specifications

General. Construction operations shall be carried out in such a manner and sequence that erosion and air and water pollution will be minimized and held within acceptable limits. Construction methods that enhance fish and wildlife will be used where practical. Trees, stumps, and brush removed from the construction area may be piled for fish and wildlife habitat when approved by the landowner/user.

The completed job shall present an appearance of good workmanship and shall conform to the line, grades, and elevations shown in the drawings or as staked in the field.

All operations shall be carried out in a safe and skillful manner. Safety and health regulations shall be observed and appropriate safety measures used.

Site preparation. Work from one side as much as practical. Clearing shall consist of felling and disposing of trees, snags, logs, brush, stumps, and rubbish from the designated areas shown on the plans. Special attention shall be given to protecting and maintaining key shade, food, den trees, and visual resources. Trees to be left standing and uninjured within the clearing limits shall be marked. Removal of any trees and brush shall be done in such a manner as to avoid damage to other trees and property.

All trees, stumps, brush, and similar materials that are to be removed from the site will be disposed of in such a way as to have the least detrimental effect on the environment. Material that is buried shall be covered with a minimum of 2 feet of earthfill plus the specified depth of topsoil in designated areas.

Excavation. Excavated material should be deposited as convenient along one or both sides of the channel in spoil banks except where needed in a specific location for construction of protecting levees or for other purposes. Spoil shall not block drainageways into the channel. In stable soils the material may be deposited so that spoil will slope toward the field from the

edge of the channel. Spoil shall be smoothed and shaped as shown on the drawings. When graded, spoil slopes should be 3:1 or flatter depending upon land use. In all cases spoil banks shall be smoothed to the extent that vegetation can be established.

Fill placement. Material placed in the fill areas shall be free of detrimental amounts of sod, roots, frozen soil, stones over 6 inches in diameter and other objectionable material. The distribution and gradation of materials shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material if so specified.

Moisture control. The minimum moisture content of the fill material and foundation shall be such that, when kneaded in the hand, the fill material will form a ball, which does not readily separate. The maximum moisture content is when conditions are too wet for efficient use of the hauling and compaction equipment.

Materials. The riprap and armor material shall conform to the gradation shown on the drawings and be a durable rock. Riprap or armor shall be dumped or placed in the manner consistent with good construction procedures and to the lines and grades shown on the drawings.

The area to be covered with a filter fabric or filter blanket shall be reasonably smooth. An even thickness of filter material shall be placed on the prepared surface. Care shall be exercised when placing the riprap and armor to insure that the blanket is not ruptured or displaced.

Other materials used in construction of an open channel will be as specified on the drawings or as otherwise specified.

Structures. All structures and other related protection devices shall be installed as the work progresses to permit proper functioning of the ditch and to prevent the least environmental damage during the installation period.

Finish and cleanup. Construction areas will be finished in a relatively smooth condition ready

for seeding. All rocks 3" in diameter or larger and roots shall be removed from the areas.

Construction tolerances. The following are guidelines for open channel construction:

Allowable variation of the constructed grade should not be more than 1.0 foot below nor 0.2 foot above design grade.

Vegetative establishment

Vegetation will be established on all disturbed areas such as channel slopes, berms, spoil and other areas except when bank materials or land use conditions are such that vegetation is impractical. Trees and shrubs should be established where practical. Disturbed areas are to be final graded and seeded or planted to trees as soon as possible after exposure. Use daily seeding on channel banks, whenever possible. Planned trees and shrubs shall be established according to Technical Guide Specification 612, Tree/Shrub Establishment.

Gullied and uneven areas will be smoothed before attempting to prepare seedbed.

Apply lime to raise the pH to the level desired for species of vegetation being seeded if needed. Rate should be determined by soil testing. If soil test recommendations are not available, a minimum of 2 tons/acre should be applied.

Fertilize according to soil tests or at a minimum rate of 1000 lbs. of 12-12-12 fertilizer (or its equivalent) per acre as soon as the measure has been constructed within the seeding periods. Apply 150 lbs. per acre of ammonium nitrate 6-8 weeks after seeding on soils low in organic matter and fertility unless this time frame extends into an inactive growing period. In this event, the additional fertilizer should be applied during the next active growing period.

Work the fertilizer and lime into the soil to a depth of 2-3 inches with a harrow or disk. Prepare a firm seedbed with a cultipacker or cultipacker type seeder.

Seed on of the following grass mixtures during the preferred seeding periods of March 1 to May 10 or August 10 to September 30.

When construction is completed between May 11 and August 9, a temporary cover crop should be established using one of the following:

<u>Species</u>	<u>Minimum Rates</u>
(1) Wheat	150#/acre
(2) Rye	150#/acre
(3) Spring oats	100#/acre
(4) Annual rye grass	20#/acre
(5) Corn	150-300#/acre

After August 10, temporary cover should be removed or incorporated, fertilizer applied, seedbed prepared and permanent seeding done in a normal manner.

When construction is completed between September 30 and March 1, prepare seedbed, fertilize and mulch according to recommendations. Seed should be applied over mulch sometime between December 1 and March 1. When this seeding method is used, seeding rates should be increased by 50%.

On critical sites, mulch with 1-1/2 to 2 tons straw per acre. Anchor the mulch with asphalt spray, netting or a mulch anchoring tool. In areas such as sharp breaks in channel slopes or where excessive velocities could cause bank scour, paper netting, jute netting, rock lining, erosion control blankets or sod should be used.

Surface Drainage Seed Mixtures

<u>Species</u>	<u>Seeding Rate (PLS*)</u>		<u>Suitable</u> pH	<u>Site Suitability</u>		
	<u>lbs/</u> <u>acre</u>	<u>lbs/1000</u> <u>sq. ft.</u>		<u>Well</u> <u>Droughty Drained Wet</u>		
1. Tall fescue	20	0.5		2	1	
Smooth bromegrass	20	0.5	5.0-8.0			
2. Reed canarygrass	18	0.4	3.5-7.5	2	1	
3. Ky. bluegrass	20	0.5				
Creeping red fescue	20	0.5	5.8-7.5	2	1	
4. Tall fescue	35	0.8	5.5-8.3	2	1	2

Note: Site Suitability

1 – Preferred 2 – Acceptable

* - Pure Live Seed = PLS

Mixture 3 may be used through urban or similar areas where lower growing vegetation is desired and close mowing will be practiced; also withstands shade better.

Five pounds of crownvetch seed per acre may be added to mixtures 1, 2, or 4 where high banks will be frequently flooded.

OPERATION AND MAINTENANCE

A maintenance program shall be established by the landowner/user to maintain capacity and vegetative cover. Items to consider are:

1. Do not graze protected area during vegetative establishment and when soil conditions are wet.
2. Fertilize to maintain a vigorous vegetative cover. Caution should be used with fertilization to maintain water quality.
3. Mulch, spray or chop out undesirable vegetation periodically to prevent growth of large woody-stemmed weeds, water plants such as cattails or trees (such as willows) which impede flow. Caution should be used to use only chemicals approved for this use on the label.
4. Promptly repair eroded areas.
5. Remove silt and sediment accumulations in the channel cross-section as soon as practical to prevent buildup and growth of undesirable vegetation.
6. Reestablish vegetative cover immediately where scour erosion has removed established seeding.
7. Keep inlets to side drainage structures open.
8. Keep subsurface drain outlet pipes open and protected. Maintain animal guards in proper operation.

9. Periodically inspect area for signs of undermining or instability and, if any are observed, take immediate action to protect from further damage.

Requirements for operating and maintaining all drainage mains and laterals having drainage areas in excess of one (1) square mile shall be according to the standard for open channels (582).